What we did

ITV

in the 60s

John Woolston *describes his introduction to a Midlands steelworks*

My first experience of a steelworks and rolling mill plant was at Bilston, Wolverhampton and Birchley works located as the name suggests in the Black Country (home to Enoch and Eli and the pig they put on the wall to watch the procession.)

Black Country Living Museum

In the first week, to gain experience as a young salesman, I was put on a night shift with a shift manager in the melting shop. The furnaces were open hearth and the row of furnaces and the men servicing them could have come from the 19th century. The men were dressed in all varieties of old clothes the only common element was a leather apron and a pair of clogs. To start the melting process the furnaces had to be lined with refractory material which was shovelled into the red-hot hearth of the furnace. Rather foolishly I asked one of the men if I could have a go. I could hardly lift the shovel and its load and only just managed to put the refractory into the front of the furnace. I have never experienced heat like that. One shot was enough yet these men kept up a continuous effort until the furnace was fully lined.

The rolling mill at Birchley was equally impressive to a young man. Imagine a large warehouse with a polished steel floor, In the middle were a series of steel roll stands each manned by two men with leather aprons and clogs but also extra layers of rags wrapped around the lower legs and a pair of large tongs. Suddenly a length of red-hot steel bar appeared and was grabbed by the men's tongs and passed into the next roll. This was a dangerous place as the smaller section bar moved very quickly and the larger section had a great weight but I never saw a man miss the bar or an accident, though horror stories of men losing legs were told in the pubs. To cross the mill often entailed walking over the moving red-hot bars. Even I managed to do this without thinking after a week or so!

Black Country Living Museum

All these places no longer exist no doubt for the best. But people who have not seen the work done in those days cannot comprehend the sheer effort and skill of those Black Country men, albeit to a man, supporters of Wolverhampton Wanderers and West Bromwich Albion!!

John Dixon's *memories of the Bessemer Converter*

Tierney Photography

Visitors to Kelham Island Museum will be familiar with the Bessemer Converter which stands at the entrance.

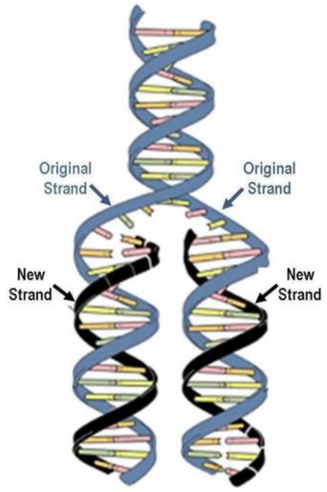
Originally it was one of two 25-ton steelmaking vessels located at Moss Bay Steel Works, Workington, in Cumbria, the last of their kind to operate in the UK. Their steel was used to make the rails used in railways in all parts of the world. When steelmaking ceased at Workington in 1974, the vessel was acquired by Kelham Island Museum and installed in its present location.

Tata Steel UK

When I graduated in 1965, I joined the United Steel Companies Ltd as a member of a research team working on the development of specialised instrumentation for use in the steel industry. I was assigned to the team looking at way of measuring the temperature of steel during its treatment in the Bessemer Converter. We carried out our work on Number 1 Converter which now stands at Kelham Island. The photograph shows the converter in operation.

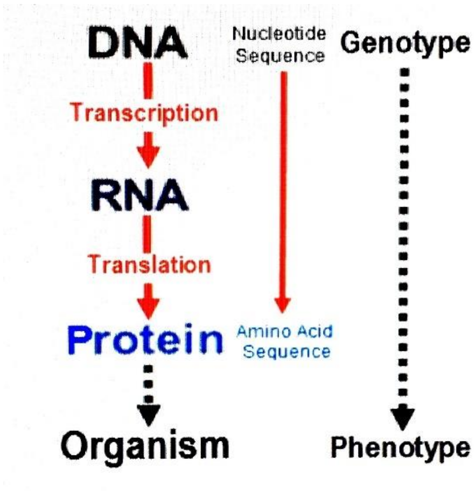
***John Guest** describes his early career as a microbiologist*

The most important advance in Molecular Biology during the 1960s was solving of the Genetic Code. In the 1950s it became generally accepted that genes are composed of DNA and in 1953 James Watson and Francis Crick deduced the structure of DNA based in part on information from the Rosalind Franklin and Maurice Wilkins laboratories. So, DNA is a double helical polymer consisting of two polynucleotide strands loosely joined by bonds between specific pairs of nucleotide bases: G-C (guanine with cytosine) and A-T (adenine with thymine) across the two strands (Fig. 1). This structure revealed how a DNA duplex containing genes can be replicated by the synthesis of new strands on each of the original template strands and then how the new hybrid duplexes can be segregated into two daughter cells upon cell division, thus allowing each daughter cell to receive copies of the genes present in the mother cell.



John Guest

Fig. 1. DNA Replication and Segregation

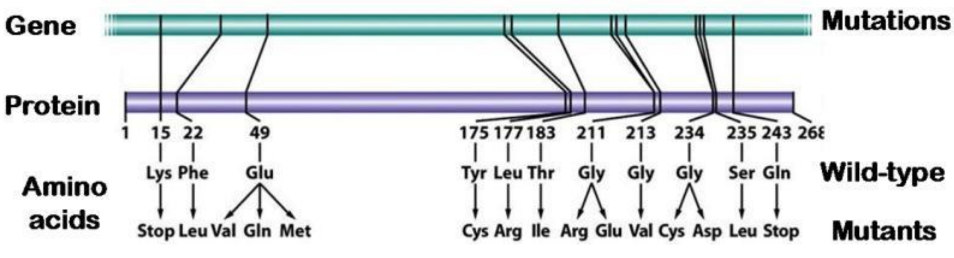


John Guest

Fig. 2 The Central Dogma (Crick, 1957)

The genius Francis Crick, proposed that all of the information needed to propagate cells is encoded in the DNA despite the fact that DNA molecules have only four variable components, the nucleotide bases G, A, T and C. Crick also proposed the mechanism by which the information in the genes defines the structures of all the cellular proteins: enzymes, regulators and structural proteins. This is known as the 'Central Dogma' of molecular biology (Fig. 2). It is a one-way process in which the DNA sequence of a gene is transcribed into an RNA copy (transcription) and the information in the RNA is then translated from the RNA into the amino acid sequence of the corresponding protein product (translation). In effect it relates the genotype of an organism or cell to its phenotype. Transcription is catalysed by an RNA polymerase and translation is mediated by the ribosome, a huge nucleoprotein machine.

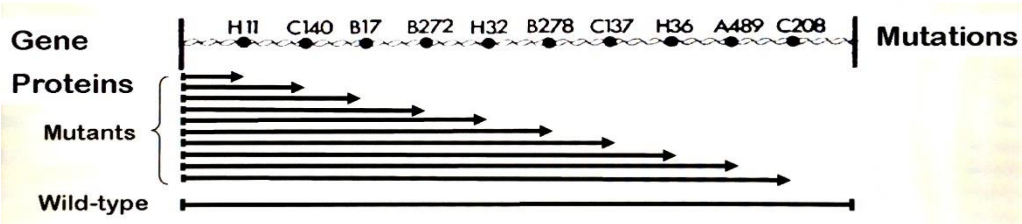
It had been assumed that the gene and protein must be linearly related but this was not formally established until 1964 in the laboratories of Charles Yanofsky in Stanford California and Sidney Brenner in Cambridge England. Yanofsky showed that the positions of mutations in an *E. coli* gene (*trpA*) encoding an amino-acid biosynthetic enzyme (tryptophan synthetase, TrpA) produce substitutions at corresponding positions in the amino acid sequence of the protein (Fig. 3).



John Guest

Fig. 3. Gene-Protein Colinearity: *E. coli* Tryptophan Synthetase (Yanofsky)

The Brenner group, working with an *E. coli* virus showed that mutations causing premature synthesis of the virus head protein produced shorter proteins whose lengths corresponded to the positions of the mutations in the virus gene (Fig. 4).



John Guest

Fig. 4. Gene-Protein Colinearity: *E. coli* Virus Head Protein (Brenner)

Already by 1961 the Crick and Brenner group had published a landmark paper describing some elegant experiments and important deductions on the general nature of the genetic code for proteins (Crick *et al.* 1961. Nature *192* 1227-32). They concluded that the genetic code is a triplet code in which three nucleotide bases (a codon) encode one amino acid, that the codons are neither overlapping nor separated by spaces, and that the sequence is read from a specific starting point. They further deduced that the code is highly degenerate, *i.e.* most of the 64 potential codons (permutations of 3 from 4 different bases) encode an amino acid (because the DNA compositions of different organisms varies far more than their amino acid compositions), and that a limited number of untranslated triplets may serve as stop signals. Their work with mutants of a bacterial virus was based on the use of acridine dyes which disrupt a gene by either adding or deleting a base from the DNA sequence. They found that over small segments of a gene inactivation by a deletion mutation (-) could be reversed by an addition (+) and *vice versa*, indicating that misreading of the DNA between the mutations had little effect on gene function. More important, they observed that two further mutations of the same type to give +++ or - - - also reactivated gene indicating that the genetic code is a triplet code. In the triple mutants one amino acid is either added or deleted from the respective protein products.

In the same year (1961) studies on the genetic code were totally transformed by a newcomer to the field using a radically different approach. He was Marshall Nirenberg, who with his co-worker Heinrich Matthaei, altered the course of history by identifying the first amino acid codon. They used cell-free extracts of *E. coli* that incorporate radioactive amino acids into proteins and observed a 12-fold increase in incorporation upon adding a synthetic RNA polymer (polyU). The increased incorporation was then traced to just one of the 20 amino acids, phenyalanine (Phe). It clearly indicated that the triplet codon for Phe must be UUU. Uracil is the nucleotide base in RNA corresponding to thymine (T) in DNA, so the DNA codon for Phe must be TTT. This was the first word in the genetic code to be read. In the same way polyC and polyA were found to encode proline (Pro) and lysine (Lys), respectively. Severo Ochoa, already a Nobel Prize-winner, competed with Nirenberg using copolymers of two bases in different proportions. These contained codons for additional amino acids *e.g*. serine and leucine in polyUA and tyrosine in polyUC, but their codons could only be identified by composition not sequence. By 1962 potential base compositions (but not sequence) had been identified for almost all of the 20 naturally occurring amino acids. Clearly a new approach was needed to crack the code.

The breakthrough came in two ways. Nirenberg developed a triplet binding assay in which each of the 64 RNA triplets was tested for their ability promote specific binding between an amino acid intermediate in protein synthesis (aminoacyl-tRNA) and the protein-synthesising ribosome. On the other hand Gobind Khorana synthesised RNA copolymers with defined repeating triplets (rather than random triplets) and analysed the sequences of the proteins they encoded. So by 1966 all of the codons had been assigned to amino acids except for three: the 'nonsense', 'stop' or 'chain-terminating' codons. Two were already known to bacterial geneticists as *amber* (UAG), the mutants used by Brenner in Fig. 4, and *ochre* (UAA). In 1967 they were joined by the third designated *opal* (UGA). The methionine codon UAG had already been shown to be a 'start' codon, initiating translation when located at the beginning of a gene.

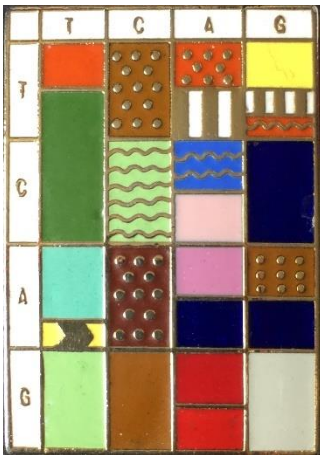
Second letter

First letter	U	C	A	G	Third letter
U	UUU, UUC Phe UUA, UUG Leu	UCU, UCC, UCA, UCG Ser	UAU, UAC Tyr **UAA Stop** **UAG Stop**	UGU, UGC Cys **UGA Stop** UGG Trp	U C A G
C	CUU, CUC, CUA, CUG Leu	CCU, CCC, CCA, CCG Pro	CAU, CAC His CAA, CAG Gln	CGU, CGC, CGA, CGG Arg	U C A G
A	AUU, AUC, AUA Ile **AUG Met**	ACU, ACC, ACA, ACG Thr	AAU, AAC Asn AAA, AAG Lys	AGU, AGC Ser AGA, AGG Arg	U C A G
G	GUU, GUC, GUA, GUG Val	GCU, GCC, GCA, GCG Ala	GAU, GAC Asp GAA, GAG Glu	GGU, GGC, GGA, GGG Gly	U C A G

Fig. 5. The Genetic Code, showing the RNA Codons for the 20 Natural minoAcids

(U is replaced T in DNA Codons)

John Guest



John Guest 11

Fig. 6. A Enamel Brooch (22x32 mm) Depicting the Genetic Code

The Genetic Code as defined for *E. coli* (Fig. 5) is highly degenerate, different amino acids can be encoded by 6, 4, 3, 2, and 1 codon. Initially it was assumed that the code would be identical in all organisms but 15 minor variations have been found, mainly in the use of stop codons for amino acids *e.g*. UGA for Trp in mitochondria where AGA and AGG may also be used as stop codons. The use of synonymous codons for one amino acid varies widely in different species. Very surprisingly, 10 years after the code was solved it was found that genes are not necessarily continuous stretches of coding DNA. Unlike bacterial genes, genes in viruses and eukaryotes (organisms containing nuclei) may contain coding regions (exons) interrupted by non-coding regions (introns). These genes are transcribed into a continuous pre-mRNA from which the introns are excised to produce the mRNA that is then translated by the ribosomes. It means that the genes in DNA are not necessarily strictly colinear with the protein they encode. In this field Nobel Prizes in Physiology & Medicine were awarded to Crick, Watson and Wilkins (1962) and to Nirenberg, Khorana and Holley (1968). Ochoa (1959) and Brenner (2002) received Nobel Prizes for other work.

Personal reflections: Scientifically the sixties were probably the most rewarding and most challenging of my career. After graduating in Biochemistry at Leeds University in 1957 I went to the Department of Biochemistry Oxford led by Professor Sir Hans Krebs, the Nobel Prize-winning professor formerly in Sheffield. There I spent five years working on metabolic roles of two vitamins (folic acid and vitaminB_{12}) in the bacterial biosynthesis of the amino acid, methionine. I was awarded a DPhil Degree and from 1960 continued working on the same project as a post-doctoral Research Fellow funded by Guinness's until the end of 1962. I was using bacterial mutants for my enzymological studies and realised the next step would be to use genetics to identify the relevant genes and study the regulation of their expression. I was also very aware of the rapid and exciting advances taking place in Molecular Biology and Bacterial Genetics. I'd been enthused by hearing a lecture by Sidney Brenner on the nature of the genetic code, and by a series of lectures by George Beadle who was in Oxford when he was awarded a share in a Nobel Prize for the 'One-Gene One-Enzyme Hypothesis'.

It was time to get some relevant experience and, where better than in the USA, at the same time picking up the valued BtA (Been to America) qualification? I was very lucky to be accepted by Charles Yanofsky a world class scientist and extremely pleasant person, studying genetic aspects of the biosynthesis of another amino acid, tryptophan, at Stanford University, California. It was an ideal place scientifically, socially and environmentally, having attracted numerous Nobel Prize winners to its delightful campus, equable climate, and its proximity to San Francisco, the Pacific Ocean and the magnificent Sierra Nevada.

I went for one year but stayed for all of 1963 and 1964. Charley wanted me to work on the amino acid sequence of the tryptophan synthetase A protein. It wasn't the bacterial genetics project I'd expected, but it pleased me because when I graduated in 1957 I wanted to work on proteins in Cambridge with Fred Sanger who'd recently determined the first amino acid sequence for a protein, insulin. I ran two amino acid analysers more or less 24/7 sequencing protein fragments. Eventually the completed sequence of 264 amino acids was the longest to be published. For several years it held the Guinness Record for the longest chemical name and there was a cartoon in *Punch* showing a molecule in a laboratory saying *'Hello, I'm Methionyl-glutaminyl-arginyl- - etc - - serine, but you can call me* $C_{1289}H_{2051}N_{343}O_{375}S_8$'.

I used wild-type protein and also the inactive or partially-active proteins from mutant bacteria and their revertants and we identified mutational substitutions at sufficient independent sites to demonstrate the co-linearity between the gene and the corresponding protein (Fig. 3). In addition, we accumulated a lot of data on the coding relationships of the amino acids substituted by mutation. There was never enough data to solve the genetic code due to the code's extreme degeneracy, but it did mean we could define for the first time which of the synonymous codons encoded specific residues in the sequence. For example, the *in vivo* codon for Gly211 in Fig. 3 was identified as GGA, not GGU, GGC or GGG (Fig. 5). This was important at the time but trivial now.

As I was about to leave I learned a little genetics doing some crosses using a bacterial virus, phage P1, to mediate gene transfer from a donor strain to a recipient strain (transduction).

Charley devised a pair of crosses between the mutants in which adjacent bases in two Gly codons are altered and wild-type recombinants could be selected, in order to determine the orientation of the codons in the gene *e.g.* GGA or AGG. The mutants are those shown for Gly211 and Gly234 in Fig. 3. I took one cross back to Oxford and Charley did the other. Such crosses between adjacent bases occur at the lowest possible recombination frequency, far lower than the frequency of spontaneous reversion so the crosses were carefully designed to exclude this problem. From the results we were able to deduce which of the two strands of the DNA in the double helix carries the 'sense' and which has the 'antisense' and then how they are oriented with respect to the mRNA and the protein molecules encoded by the DNA. To be able to contribute to this research was amazing. I still have in my possession a rare enamel brooch depicting the genetic code in patterns and colours (Fig. 6). It was made by a daughter of Roger Milkman, an eminent Professor of Genetics in Iowa who gave it to me. It certainly reminds me of that remarkable time. So, goodbye to California: its wonderful National Parks teeming with wildlife; its mountains to climb; and easy camping.

Back in Oxford in 1965 I had to find a lectureship and develop significant and fundable research projects of my own. It was a good time for lectureships because new universities were being created and existing universities were investing in molecular biology and genetics. I was offered no less than eight lectureships including one at Oxford University. I didn't want to stay in Oxford because, as a provincial graduate one was always an outsider. I discovered years later in response to requests from the Alumni Fund that my DPhil and that of several provincial contemporaries had not been registered by my College. It may be different now but most of Krebs' provincial staff was leaving Oxford at the time. I chose to come to Sheffield because it had a strong tradition in Microbial Biochemistry and I had a very high regard for Rod Quayle, the newly appointed Professor of Microbiology (later Vice-Chancellor at Bath). Most of the original staff had left and I was surprised to see how poor and cramped the labs were. Nevertheless, I was shown plans for my office and laboratory in a new building already being constructed, and I'd observed that the best work was often done in poor surroundings. I predicted there'd be much longer delays for establishing research at the other universities. Unfortunately, university politics being what they are, my allotted space went to the Medical Faculty and it was seven years before I had my own office and laboratory.

I was extremely busy, writing up the Stanford work for publication, producing lectures and practical classes for immediate use and developing research projects, in a shared lab having space for only one research student and a technician. My original methionine project had been taken up by others so I embarked on several new projects aimed at learning bacterial genetics using my own gene-protein systems and discovering how gene expression is regulated. The most fruitful projects came from isolating mutants of *E. coli* that were either unable to grow aerobically or unable to grow anaerobically (*i.e.* without oxygen). Some were defective in the central metabolic pathways present in all aerobic organisms (the Krebs Cycle); others lacked the ability to use nitrate or fumarate instead of oxygen, and a most important class lacked an oxygen-sensing global regulatory protein needed to switch on anaerobic metabolism in the absence of oxygen. They provided me with material to fill a scientific life-time exploring the structures and mechanisms of the enzymes and the regulatory proteins that maintain living organisms. Over the following 35 years I was ably assisted by a total of 34 PhD students and 26 post-doctoral fellows, making use of gene-cloning and sequencing, genetic engineering and metabolic engineering methods: that is doing things I would never have dreamt possible at the outset.

***Jim McQuaid** describes his work at the Safety in Mines Research Establishment*

After a PhD at Cambridge, I came to Sheffield in 1966 to take up a 3-year appointment at the Safety in Mines Research Establishment. My PhD research had been on a proposed method of cooling the US Space Shuttle, then in its development phase, during re-entry to the atmosphere. My research at SMRE was on an apparently very different but in one aspect actually very similar problem - that of firedamp explosions in coal mines. These were a regular occurrence up to that time; for example, in 1965 an explosion at Cambrian colliery in South Wales had resulted in the deaths of 35 miners. SMRE had central laboratories in Broad Lane and extensive field laboratories in Buxton for the conduct of experiments including full-scale explosions. A mine explosion usually starts as a gas explosion and develops into a very destructive explosion of the coal dust ever present in the mine roadways.

SMRE was part of the Ministry of Power. It was independent of the National Coal Board which owned and operated the mines. Firedamp, which is mainly methane, is naturally released when coal is mined. The traditional way of minimising the danger was by dilution with mine ventilation, though development was underway in the NCB on extracting the firedamp from the coal seam ahead of the mining operation, as had been advocated by Michael Faraday in 1844. The firedamp was drawn into a system which piped it to the surface of the mine where it was used as an energy source.

The fundamental difficulty with control by the ventilation was that the density of firedamp is only half that of air and hence the emitted firedamp is subjected to a positive buoyancy force which causes it to rise and form a stable layer at the roof. The mine ventilation then has to provide the energy needed to induce mixing and dilution of the firedamp. To avoid ignition, the firedamp must be diluted to below the lower explosive limit of 5 % in air and hence if the ventilation is weak for any reason, there will be a build-up of an explosive mixture. At Cambrian colliery, the ventilation was weakened through being short-circuited through a door that had accidentally been left open. My research focused on the fluid mechanics of firedamp roof layers. It complemented other SMRE research on instrumentation for monitoring of the mine atmosphere. However, as it happened the need for action on coal mine explosions was moving to a downward trajectory in the UK. The Cambrian explosion turned out to be the last major explosion attributable to firedamp layering and the problem was effectively conquered by practical improvements to firedamp drainage and mine ventilation. The late 60s therefore brought an end to the terrible toll of miners' lives in great explosions that had regularly occurred since the early 1800s. But as one era ended, another began. SMRE transferred to the new Health and Safety Executive in 1974. The transfer meant that the capabilities in research and facilities at SMRE were available to HSE in tackling a broader spectrum of industrial safety problems. For example, there was growing concern about the developing threat of large-scale accidental releases of flammable and toxic gases to the atmosphere. These often involve gases that are heavier-than-air so that dilution to safe levels is inhibited by their negative buoyancy - an 'upside-down' variant on the firedamp layering problem in mines. Since it is not feasible for me to show a photograph of a firedamp roof layer in a mine, I show instead a photograph of a heavier-than-air cloud at ground level in the atmosphere. The photograph shows the aftermath of an actual industrial accident in the US. In the accident, a very large storage tank of ammonia (liquified by refrigeration) used in fertiliser production overflowed when being filled from a river barge. The liquified ammonia spilled down to the ground and evaporated as it mixed with the atmosphere. Although ammonia is lighter than air at the same temperature, the resultant mixture of air and cold ammonia gas was denser than the ambient air and the cloud of this mixture collapsed and spread under gravity over the surrounding countryside, as can be seen in the photograph. The storage tank can be discerned in the background. Since ammonia is toxic and slightly flammable, the accident resulted in a serious hazard. It is not hard to imagine a firedamp roof layer similarly spreading along the roof of the workings of a mine.

Jim McQuaid

As will be evident, my 3-year appointment to SMRE in 1966 was extended and, after several job changes, I stayed with at HSE until 1999 (though latterly in London) – and the Space Shuttle did fly, though using a different method of counteracting the effects of re-entry heating from that of my PhD research!

Roger Viner's *memories of Viner's Cutlery*

Roger joined the Viner's Company in 1960s, having worked there as holiday jobs while at schools & University. His first position was assistant to Sales & Marking Director. His later involvement related particularly with the French subsidiary and certain other overseas markets. He later became UK Sales & Marketing Director, and later Finance Director. Eventually he became Company Chairman.

Our Broomhill Website

The company was founded in 1904 by Roger's great uncles, brothers of his grandfather, who joined the company a few years later. A number of "little mesters" and smaller companies were brought together into a single organisation originally sited at Tiger Works on West Street. The company became significantly "integrated vertically", manufacturing everything from the raw material to finished product. Basic metals were used to produce nickel silver pewter and sterling silver which were cast and rolled prior to processing into finished products. Viners were early adopters of stainless steel for cutlery, forging knives from bought-in steel.

The company was highly innovative in manufacturing and marketing techniques, making continual improvements in all areas. It was one of the first companies to adopt a 5-day week. Its versatility was apparent in the two world wars when some munitions were produced. It grew to be the leader in the cutlery industry reaching its post-war zenith in the 1960s with subsidiaries in Ireland, Australia & France.

The contraction of cutlery industry & its suppliers started in 1970s with removal of Retail Price Maintenance. Imports from Japan, Hong Kong, Korea, Indonesia increased price competition. Viners' response was to increase productivity by automation, introducing the use of computer systems, concentrating on specialised products, and importing some finished items.

***Brenda Long** remembers her father's work as an optical and electronics engineer*

Brenda Long

Having built a black and white TV in time for the 1953 Coronation (watched in our house by as many neighbours as could squeeze in!), dad built the new colour TV as soon as the component parts became available. The change over from 405 to 625 lines began in 1963, and to buy a ready-made 625 colour TV was prohibitively expensive for many people. He built the TV in his shed with my help.

Dad was the Optics service manager for Rank Taylor Hobson in Leicester, and as far back as 1939, the company supplied over 80% of the world's lenses for film studios. He spent many years travelling all over the world to service the lenses in film and TV studios, and at major events, such as the Mexico Olympics, when live colour broadcasting was watched by over 600 million viewers. The attached BBC photo highlights a historic event that happened at the Mexico Olympics, when two black American athletes, Tommie Smith and John Carlos, gold and bronze medallists in the 200m, made a silent protest against continuing racial discrimination of black people in the United States.

Wikipedia

***David Scott** recollects his Chesterman days.*

Sheffield City Council

Great changes were afoot at Bow Works in February 1961. There I was, on my first day at Jimmy Chestermans, after having climbed the long stairs behind the impressive wooden doors on Pomona Street, asking the prim lady behind the window in the dark but highly polished oak reception corner, for the Personnel Manager. A <u>proper</u> engineer at last, I thought, ready to set the world aright with my amazing knowledge. Laycock's had done me proud, there would be overdrives on all the new products I was going to invent for J C's. Drawings would be done to BSS 308 without exception and there would be no mistakes.

How very wrong I was!!!

It soon became apparent that there was a well-established engineering hierarchy. The tool room foreman, Billy Badger, seemed to have the last word on all matters, new and old. To get anything done it was necessary to spend much energy in getting him to talk you round to doing it his way. Even the technical director, David Antill, owner of a Jaguar XK 120 kept in the garage beneath the drawing office, was under Bill's control, probably because the car's repair and maintenance was looked after by the toolroom staff. Bill's eyrie dominated the factory yard in splendid isolation. Access was by an out-doors flight of steps into what seemed to be a greenhouse wherein laboured the staff. Both body and spirit had suffered on arrival at these dizzy heights.

In the drawing office there dwelt another keystone of Chesterman's engineering reputation. Fred. Despite all the changes happening around him, (such as the likes of me), Fred Clark(e) had an encyclopaedic knowledge and understanding of the Chesterman products of the past. I don't think he knew too much about the engineering of those products, but Fred could find the drawings and specifications stashed in forgotten, dark and dismal corners of the slowly rotting buildings. He was a natural kindred spirit for Billy Badger and they were, to some extent, mutually dependant on each other for survival as I think they had regular private meetings during the day, possibly to plan Billy's tomorrow's injection of office tittle-tattle to David Antill. I can remember one particular occasion when we had Sello-taped Verena Beevers, our glamorous office secretary, to her chair and very untypically, David Antill walked in. You can imagine! It had not gone un-noticed that Fred had disappeared very quickly as soon as the bondage session had started

Grace's Guide 1

We, the new brigade, used pantograph drawing boards, drawing paper and Diazo drawing prints. Fred used a flat drawing board, linen and Chinese ink. He made corrections by the deft scratching away of brittle ink without damaging the underlying woven fabric; we used an eraser. As for printing, Fred would disappear for some time with his roll of linen, coaxing an ancient arc lamp printer into action. The office lights would dip for a moment when the Frankenstein-like contraption was switched on. In due course of time Fred would emerge bleary-eyed from the inner sanctum with his prints, trying not to catch the eyes of his amused juvenile colleagues.

I believe he was a keen member of and contributor to the National Trades Technical Society and frequently asked us to attend meetings and lectures, one of which I think was delivered by himself.

***Sue Bellamy** remembers her family firm – Frederick Beatson & Sons*

British Silverware Ltd 1

My family had a factory near the City Centre on Hereford Street where they manufactured knife handles from Sterling silver, stainless steel and nickel silver which would then be silver plated. The handles were mainly made in "Parish" patterns, e.g. Kings, Bead, Queens and, my favourite, Fiddle Thread and Shell. They were sold for finishing to other companies who would have made or bought in the forks and spoons to match. Our handles were made to a high standard and the finished products were sold to many expensive shops, shipping companies and hotels. We would put company marks on the handles for cutlery supplied to the Houses of Parliament, BOAC and a number of shipping companies.

The factory was typical of an old cutlery works, built in a square around a courtyard and had a number of businesses still making knives. It was cold and draughty in winter and could be very hot in summer. I often went there with my Mum to visit Dad and other members of the family who worked there. The steps up to the warehouse were very worn and I found them difficult to walk up. I don't think that they had ever been renewed since the building was new in the 1850s.

We still used drop hammers to produce the handles and much of the manufacture was old-fashioned and not heavily mechanised. I was fascinated to watch men and women working at the different processes involved in the manufacture of handles. They were skilful and worked very quickly – fingers moving like lightning while they chatted away with the person working next to them.

Some of the surrounding area was still involved in the cutlery trade but much of it had been damaged in the war and was still a bombed site. The majority of the houses had been destroyed and the ground was used as a car park. There were very few buildings left, especially towards the Sheffield and Ecclesall Co-op at the bottom of Ecclesall Road. There were one or two houses left in Hereford Road and at one of them, someone kept a small monkey in an outhouse. I used to feel very sorry for this little creature, especially in winter when it was very cold. I would talk to it as we walked to the factory.

When I visited, the people at the factory would make a big fuss of me and give me sweets. I used to drop bits of paper through knot holes in the floorboards down onto the men working in the Hammers Shops, getting me into trouble with my Dad.

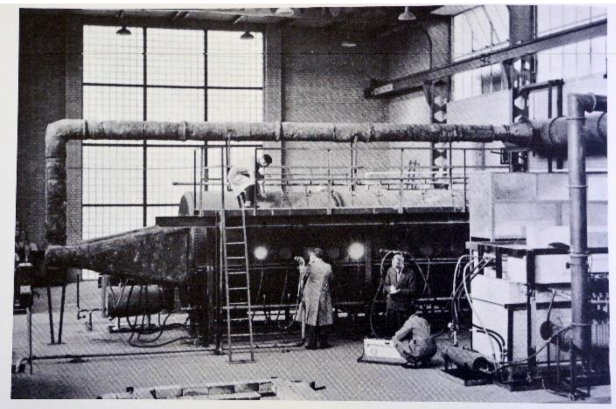
At one time, the people working there included both my parents, my grandfather, two uncles, two aunts, a great uncle and one of Dad's cousins.

When I left school, I became the "Office Lady". I have many happy memories of working there and was very sad when the building was sold and demolished. It is still an empty space and has not been re-developed.

__John Dixon__ describes furnace research in the steel industry

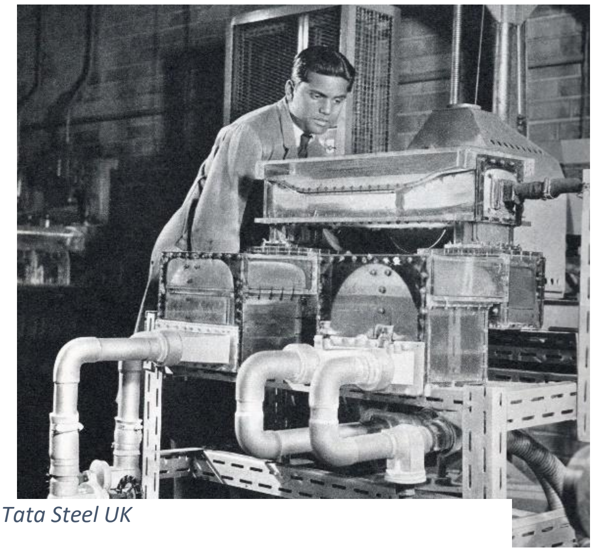
The 1960s were an exciting period for the UK steel industry with the introduction of new processes and equipment to increase output and improve product quality. At the same time, there was pressure to reduce the impact of the industry on the environment, especially by reducing the quantity of red fume released into the atmosphere. Research laboratories were much involved with these process developments and used novel techniques in order advance the design of plant and equipment.

Steel plant is often large, hot, dirty and potentially dangerous, making investigative work difficult and expensive. Some of these difficulties can be circumvented by the use of modelling techniques to simulate how a full-size piece of equipment would behave in particular circumstances. A possible approach is hot modelling in which small-scale replicas of the plant in question are used to study how temperatures, gas-flows and other parameters would behave the full-size equipment. Special instruments were used to make measurements in the model. The photograph shows a pilot-scale model of a furnace used to investigate the performance of the gas burners to be used.


Flame tunnel used for study of combustion and heat transfer

Tata Steel UK 1

An alternative approach is cold modelling in which air or water are used to model the flow of gases or liquids, including molten steel. This photograph shows a model of a steelmaking furnace illustrating the flow of gases within the plant. The model can easily be adapted to show the effect of changes of geometry, gas velocity and other factors to give confidence that the changes would have a beneficial effect when applied in practice. This technique was used extensively to design equipment to capture and filter the red fume emitted in steelmaking and contributed to the considerable improvement of air quality in Sheffield and elsewhere.


Tata Steel UK

David Scott's *memories of a pre-Baby Boomer. Born 1937*

Having survived the Sheffield blitz and armed with education at Firs Hill infant, Junior and Firth Park Grammar schools, in 1954, I, together with no less than 120 others, started a 7-year student apprenticeship in light, precision engineering at Laycock Engineering, Archer Road, where, incidentally also lay one of Sheffield's many ganister mines, the special clay being used to re-line the steel melting furnaces in Don Valley. The Apprenticeship, quite rightly, was considered to be the very finest of local schemes. Hands-on experience of 3-month long training periods in most of the manufacturing departments and later in the Jig and Tool, (AKA Pig and Fool) drawing office was consistently exhilarating and enriching, complementing my insatiable curiosity in and understanding of Physics, Chemistry and metalwork encouraged at Grammar School. The scheme allowed day release to study for ONC (Ordinary National Certificate) but HNC could only be studied at night school, thus entailing long, sometimes gruelling lectures and homework, travelling to Pond Street across slippery tramlines, at night, in frequently foul weather, on a much modified, (water injected, padded crankcase) 25cc Cyclemaster.

Post war personal transport was difficult because money was short, so from 1949 the 50s saw the introduction of a proliferation of cyclemotors, usually in the form of a smokey, 50cc two stroke engine mounted either behind the saddle or behind the bottom bracket of an otherwise standard bicycle. The distinctive metallic blue Minimotor, the gold Powerpac and the front wheel drive French Velosolex, just three of many which spring to mind, and most of which cost about £12 over the counter. The Cyclemaster and BSA Winged wheel were top end models having integrated engine, fuel tank, transmission and brakes, and cost a huge £25. Hilly Sheffield attracted more cyclemotors than most cities, probably significantly adding to our notorious smog at rush hour. With our ever increasing wealth and life expectations, the cyclemotor rapidly gave way to several lightweight motorcycles, sometimes toiling with a laden sidecars and most having the ubiquitous Villiers 125cc engine, shortly followed in the late 50s by a gaggle of micro cars (AKA bubble cars), because they could offer a family travel away from the weather. These too lasted only a short while because BMC launched the iconic Mini. I digress.

Motorised cycles were not particularly friendly when it came to girlfriends, so after passing my car driving test, I managed to buy a very odd, but endearing, recently built, electric-blue Austin 7 mud plugger "special" for £25 from a chap I met at work. Austin 7s were two a penny and, like most of them, AWW 713 had several self and driver-destruct tendencies, particularly in braking, quickly making me expert in steering round obstacles. This deficiency could be overcome by rotating the front brake operating levers 180 degrees, which, although vastly improving braking, tended to shear kingpins. I learned always to carry spares made from ½ inch silver steel, to join the little tin of rear axle woodruff keys, which too sheared regularly, and the roll of ex-army sticky tape temporarily to repair hood leaks. A small supercharger was fitted, bought from Bardwell's ex-military, open market stall, which although not making it much faster, greatly improved the torque, making traffic light starts impressive but often sheared aforesaid woodruff keys.

Black and white home photography had always been interesting since being a member of the school photo club. My parents had allowed me to convert one of the attic rooms into a dark room, where, with the assistance of Julia and later, Brenda, the mysteries of enlargement, dodging in, fixing and dry mounting, were developed.

"Special" building also interested me as it complemented my interests and developing skills, so in 1958 or thereabouts, I acquired an old, apparently rare four wheeled BSA Series 6a, and after fully stripping it to its bare components, rebuilt it into a special over a period of about 2 years. Eventually, it was sold, never having been on the road, as Brenda had become far more interesting.

Parties in the 50s and 60s usually involved taking a favourite record and maybe a bottle, Blue Nun or, if the party was likely to be really good, the Mateus Rose, the empty bottle inevitably ending up as a lamp base.

In August 1956, Laycock sent me on a difficult but transformational month at Outward Bound School, to learn about drinking tea, falling, and not falling off cliffs, having confidence, and overcoming fear and pain. OBS was considered by some to be a little like National Service square bashing. In retrospect, the experiences were wonderfully useful in later life.

Having met Brenda in September 1958, and after becoming engaged to be married shortly afterwards, we reluctantly thought it best to delay our marriage until I had done my National Service which had been looming increasingly large throughout this period. I had been irritatingly fortunate in being granted deferment twice, having failed one subject of HNC examinations every other year, but I was told, in 1960 that "pass or fail lad, you're in next year". Fortunately, National service ended in December that year, so I missed, arguably, "the experience of a lifetime" by two whole weeks. What joy, our marriage and house purchasing plans now could be advanced.

After having found a house for sale on Norton Lees Lane, we went for face to face interview with the Halifax Building Society Manager, who, after a near inquisition, eventually agreed to giving (?) us a mortgage. Thereafter, for many months both before and after our marriage, we laboured long, joyously removing many layers of sticky varnish and heavy Anaglypta, transforming our 1926 house into a 1961 family home. However, our time-consuming activities and family planning were to be briefly interrupted by the Cuban Crisis. Suddenly, the now wrinkly Government's 4-minute warning advice leaflet seemed horribly important and we found ourselves seriously thinking of mortality, and what we would do if such an event were to happen. Thankfully, the crisis evaporated together with our worries, and home building continued, interrupted only by the dreadful Sheffield Gale in February 1962. Amusingly, (in retrospect) February 16th was the **only** time we met our milkman, he doggedly delivering milk to his customers through a hail of flying slates and branches. Our roof was severely damaged because the small Rosemary tiles, retained by torching, had previously been weakened by a rogue bomb having landed nearby during the blitz. In the 60s, our town gas supply was changed to natural gas and all our gas burning appliances, including the blow torch used for burning off the varnish, were exchanged for new or converted. Similarly, later in the 60s, our round pin electrical sockets were freely changed to the current, iconic square pin format, as was the supply voltage from 200 to 240 with similar arrangements for conversion or exchange.

Sheffield trams stopped running in 1960 and we remember going to town to see the last tram running outside the City Hall. I have a particular fondness for the old Sheffield trams, as shortly after starting at FGS, our family moved to Broomhill, and for the next six years, every school day involved both bus and tram travel. I shall always remember the lozenging of the front windows as we lurched round corners, the screeching of wheels to rails when negotiating sharp corners (no differentials) and the amazing Fitzalan Square rail-set, cast as one piece in Manganese steel. The Duke of Darnall, a harmless and much-loved deranged character, often did his voluntary point duty at that location, being gently escorted away by the police when rush hour approached.